STK # 6014
$418
$208

INSTRUCTIONS FOR

SERIES 2608

CATHODE FOLLOWER

ENDEVCO CORPORATION

SERIES 2608

CATHODE FOLLOWER

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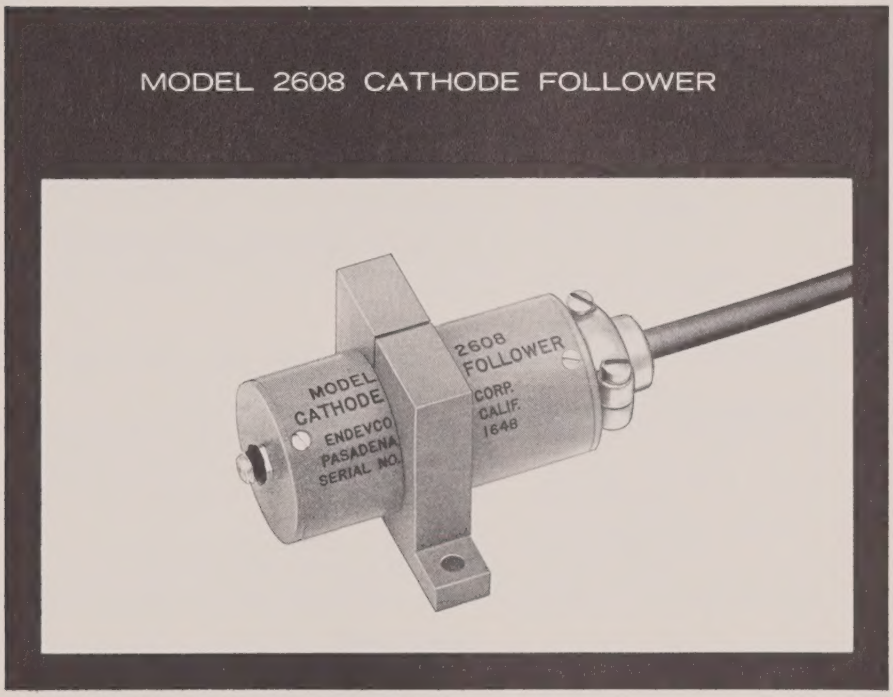
Endevco Model 2608 Cathode Followers provide for impedance change from 100 megohms to 200K ohm load with flat frequency response from 2 cps to 20 kc.

The compact (2 cubic inches) and shock-resistant construction of the Model 2608 makes this unit ideal for application in systems subjected to high level shock or vibration. The high input impedance of 100 megohms insures a wide and flat frequency range when used with Endevco piezo-electric Accelerometers, Pressure Pickups, Force Gages, et cetera.

MODEL 2608 CATHODE FOLLOWER



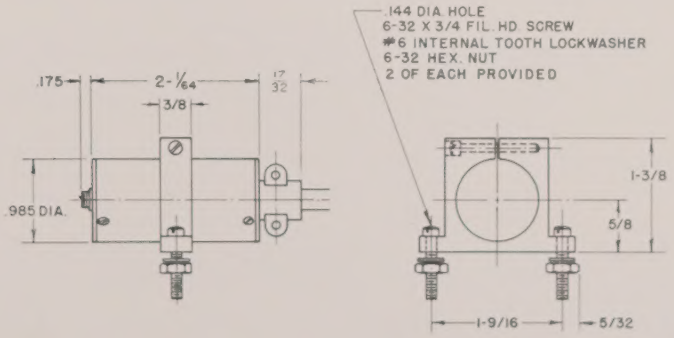
OUTSTANDING FEATURES

COMPACT DESIGN . . . . . 2 cubic inches

SHOCK RESISTANT . . . . . 100 g's, 6 millisecond sawtooth
(internal shockmount)

LINEAR OUTPUT . . . . . 5.0 volt rms ±1%

FREQUENCY RANGE . . . . . 2.5 cps to 20,000 cps ±2% with 100K load



Mounting Bracket

TWX: 7764 CABLE: ENDEVCO

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CATHODE FOLLOWER
MODEL 2608

ELECTRICAL

INPUT CHARACTERISTICS	
Input Connections:	Single ended with one side connected to case ground.
Input Resistance:	100 Megohms nominal.
Input Capacitance:	25 pf maximum.
Source Impedance:	Input source may be either resistive or capacitive. If source is resistive an isolating capacitor must be used.
OUTPUT CHARACTERISTICS	
Output Connections:	Single ended with one side connected to case ground.
Output Impedance:	500 ohms max. in series with 4 μf capacitor.
Maximum Linear Output Voltage:	20 volts rms provided max. current is not exceeded. 5 volts rms with 10 K ohm load.
Maximum Linear Output Current:	0.5 ma rms.
Residual Noise: (referred to input)	100 μvolts peak-to-peak max. with 200 pf source or greater.
Ripple Sensitivity:	4.5 μvolts per millivolt of filament supply ripple. 80 μvolts per millivolt of plate supply ripple.
Vibration Sensitivity: (referred to input)	250 μvolts rms/pk g max. with 500 pf source or greater.
TRANSFER CHARACTERISTICS	
Gain:	0.94 ±1%, at 70°F and load exceeding 100 K ohms.
Gain Stability:	±2% with power variations.
(load exceeding 100 K ohms)	±1% with temperature changes.
Frequency Response:	±2%, 2.5 cps* to 20,000 cps with 100 K ohm load. ±2%, 25 cps to 20,000 cps with 10 K ohm load.
Amplitude Linearity:	±1% of reading maximum from best straight line.
Warmup Time:	15 minutes for maximum accuracy.
POWER REQUIREMENTS	
Filament Voltage:	6.3 V DC ±10% at 200 ma nominal.
Plate Voltage:	100 to 150 V DC at 3 ma nominal.

PHYSICAL

DIMENSIONS:	2¾" long max. overall x .985" dia. (excluding bracket and 5 ft. integral cable).
WEIGHT:	7 ounces including cable.
FINISH:	Gray anodize.
MOUNTING:	Bracket (see dimensions on other side).
INPUT CONNECTOR:	Microdot Type 51-79 or equivalent.
POWER AND OUTPUT CONNECTOR:	Cannon RWK-6-22C-¼.
ACCESSORIES SUPPLIED:	Instruction manual, mounting bracket.
ACCESSORIES AVAILABLE:	Insulating tape for bracket, Extension Cable 2920-21, Output Mating Connector RWK-6-31SL (Supplied when amplifier is purchased without Endevco power supply).

ENVIRONMENTAL

TEMPERATURE:	−20°F to +170°F (−29°C to +77°C).
SHOCK:	100 g, 6 millisecond sawtooth.
VIBRATION:	0.120" DA 5-55 cps, 20 g 55 cps to 2 KC.
ALTITUDE:	0 to 70,000 ft.

PRICES

1-5: $105.00 6 and over: $95.00

Prices of Endevco Products to be exported or purchased with intent to export beyond the territorial limits of the United States are subject to special quotation.

*Calibration to 1 cps available on special order.

Endevco Corporation reserves the right to modify these specifications and/or prices without notice. Your Endevco Field Engineer is qualified to advise you regarding changes in printed information.

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TECH-DATA NO. 507	
AFFECTS All Endevco Series 2600 Amplifiers and Cathode Followers	
CLASSIFICATION	G
REVISION DATE:	7/8/60
ORIGINATOR	PLL

SIGNAL OUTPUT BIAS VOLTAGE

Many telemetry and certain other applications call for externally supplied bias voltage on the output signal lead. Typical is a +2.5 volt bias for telemetry systems.

All Endevco cathode followers and amplifiers contain a series output capacitor which is polarized. (Refer to individual schematic.) Provided the amplifier is "on" before and after the bias voltage is applied, there is no problem. However, should the bias voltage be applied with the amplifier "off", inverse voltage will probably damage the output capacitor. If there is a possibility that the bias voltage will be "on" with the amplifier "off", a non-polarized capacitor should be added in series with, or in place of, the polarized output capacitor.

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INSTRUCTION MANUAL FOR CATHODE FOLLOWER MODEL 2608

1.0 GENERAL

The Endevco Model 2608 Cathode Follower is a shock and vibration resistant impedance transformation unit for use with piezoelectric transducers such as Accelerometers; Pressure Pickups and Force Gages.

2.0 OPERATION

2.1 Power

The plate and filament voltages are supplied through the signal output connector, Cannon RWK-6-22C -1/4. A suitable source of power for the Model 2608 Cathode Follower is the portable Endevco Model 2621 Power Supply or the rack-mounting Models 2622 or 2623. Either of these electrically identical units will supply power for up to four Cathode Followers.

2.2 Signal Input

2.2.1 The signal is applied through the small Microdot 51-79 Connector on the input end of the unit. This connector mates with the Microdot 52-173 Connector on Endevco transducer cable assemblies.

2.2.2 Input signals slightly greater than 5 volts rms produce the maximum output level of 5 v rms. Appreciably larger input signals must be attenuated to prevent overdriving the 2608. (Output to 20 v rms permitted providing maximum current limitations not exceeded). The Endevco Model 2614.1 Output Standardizer may conveniently be used for this purpose.

2.2.3 The input impedance of the cathode follower determines the low frequency response of the input signal from a piezoelectric transducer. The low frequency response is a function of the RC time constant of this resistance and the total capacity of the transducer, cable, etc. Hence, for a transducer-cable combination having a given total capacity, the low frequency at which the response will be down 5% is inversely porportional to the load resistance.

For example: The Endevco Model 2221C Accelerometer, with cable attached, has a nominal capacity of 950 pf. With a load impedance of 100 megohms its frequency response will be down 5% at 4.2 cps.

See Figure 1, where f = frequency in cps., R = load resistance in ohms, C = total capacity in farads.

Conversely: Assume acceleration measurements are to be made at 10 cps with a Model 2221 Accelerometer and a Model 2608 Cathode Follower. Then $fRC = 10 \times 100 \times 10^{6} \times 950 \times 10^{-12} = 0.95$. From the curve in Figure 1 we find that the response at 10 cps will be down less than 1%.

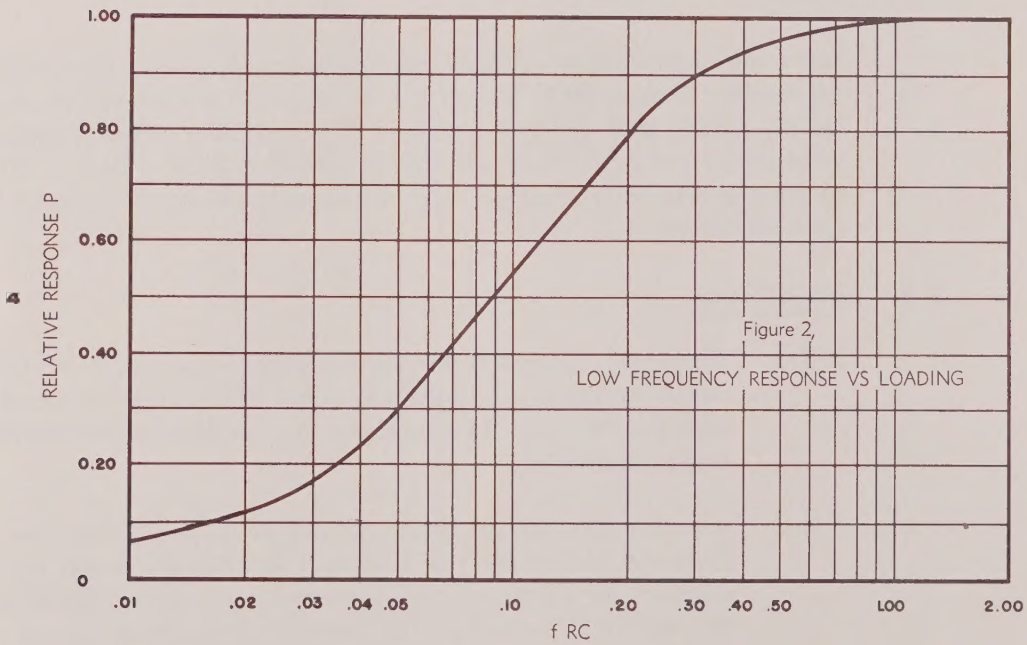
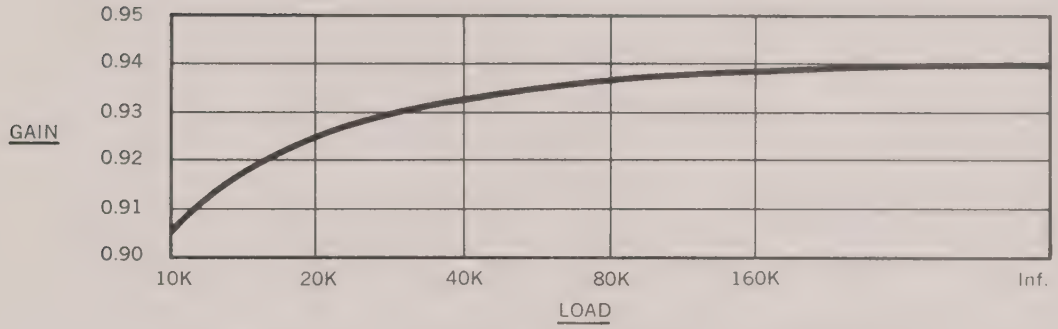


Figure 1

2.2.4 When used with other than Endevco transducers, care should be taken to ensure d-c isolation of the input circuit. Because of the high input resistance, the blocking capacitor selected for this purpose should have negligible leakage current so as not to shift tube bias.

2.3 Gain

The Model 2608 Cathode Follower, with a nominal gain of .94, is used in applications where impedance matching without amplification is required. The variation in gain with changes in load impedance is shown in Figure 2 below.



Nominal gain at room temperature with 150 volt B+, 6.3 volt filament voltage

TYPICAL GAIN VS. LOAD CHARACTERISTICS

Figure 2

2.4 Output

Maximum output of the 2608 is 5 v rms at 0.5 ma. The actual output within this limit will be the input times the gain, due allowance being made for frequency response. The response at low frequencies depends on the magnitude of the load impedance. It may be determined as follows: Let C be the 4 μf output capacitor. Let R_e be the equivalent resistance of the 470K output resistance and the load resistance R in parallel. Then,

$$\text{Relative Response} = \frac{R_e}{\sqrt{(R_e)^2 + (X_c)^2}}$$

$$= \frac{1}{\sqrt{1 + \left(\frac{R + 470{,}000}{11.8\, fR}\right)^2}}$$

3.0 INSTALLATION AND CHECKOUT

3.1 Schematic A-2608-501C and Drawing C-2608-C are included to provide installation information.

3.2 Block diagrams of various test set-ups for checking conformance with specifications are furnished in the attached "Test Procedures for 2600 Amplifiers and Cathode Followers", TD 517. The tests described cover:

1. Gain
2. Frequency Response
3. Input Resistance
4. Phase Shift

3.3 Negative filament terminal should be connected to circuit ground for minimum noise.

4.0 MAINTANANCE AND SERVICE

Very little maintenance is required. Connections should be checked for loose connections, grounds, and shorts.

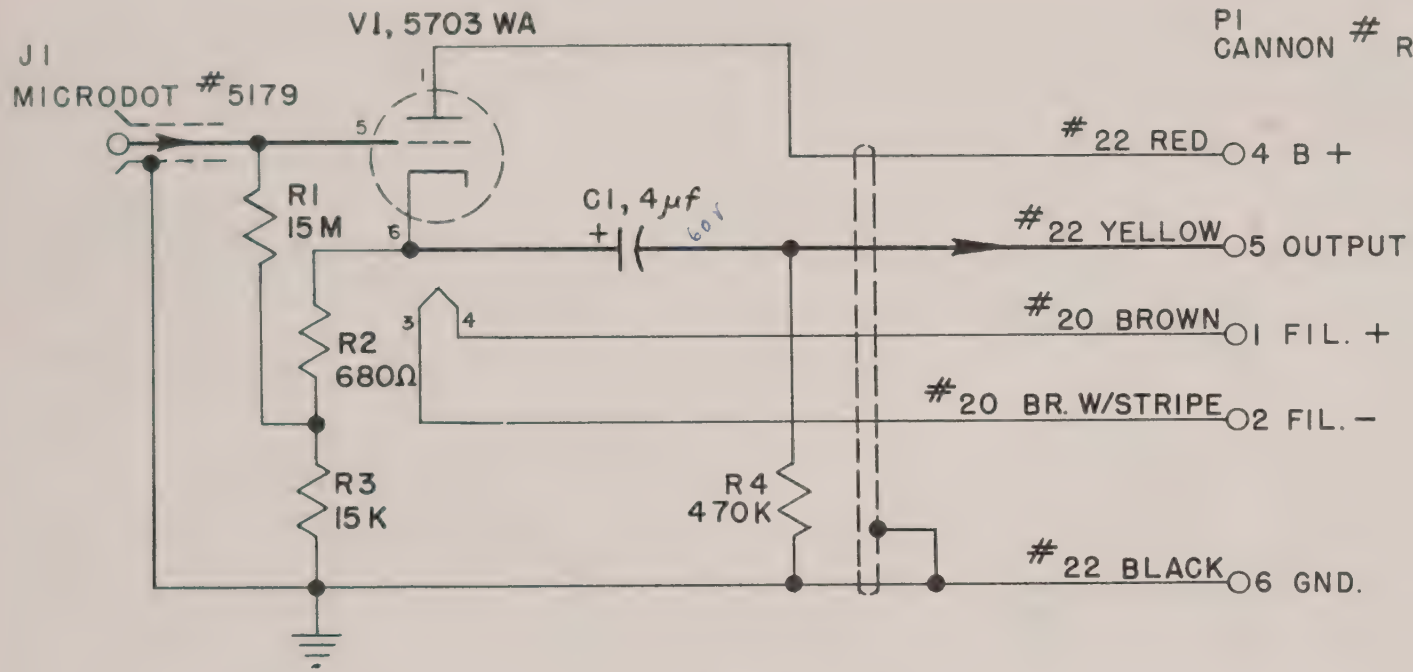
Occasional checks of the input resistance and the gain should be made. These tests are described in the accompanying "Test Procedures". Low input resistance may be due to moisture which can be removed by exposure of the amplifier to a warm, dry atmosphere.

Component identification is printed on the etched circuit board. To disassemble, release the cable clamp, and remove the three 0-80 machine screws on the input end of the unit. Note the sequence of original assembly.

If serious trouble occurs, however, the amplifier should be returned to the factory for repair. It should be accompanied by a description of the particular fault and the situation in which it occurred. See the warranty section at the front of this manual for instructions pertaining to the return of an amplifier covered by the Endevco warranty.

ELECTRICAL PARTS LIST FOR 2608

Des.#	Part	Value and Description	Manufacturer and Number	Endevco Part No.
R1	Resistor	15 M, ±10%, 1/2W, Comp.	Allen Bradley, "EB"	ER36
R2	Resistor	680 Ω, ±10%, 1/2W, Comp.	Allen Bradley, "EB"	ER15
R3	Resistor	15 K, ±10%, 1/2W, Comp.	Allen Bradley, "EB"	ER16
R4	Resistor	470 K, ±10%, 1/2W, Comp.	Allen Bradley, "EB"	ER12
C1	Capacitor	4 μf, 60 V, Tantalum	Fansteel #PP4B60A2	EC4
V1	Tube	Electron 5703WA		EV1
J1	Receptacle		Microdot #51-79	EJ3
P1	Plug		Cannon #RWK-6-22C -1/4	EP2



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CHG	CHANGE DESCRIPTION	BY DATE	CHK	APPR
6	V27 EO. ADDED NUMBER CODE TO V1 CONNECTIONS	12/11/56 GHL	12/14/56	WDB 12/14/56
5	CHANGED R1, WAS 18M; CHANGED R2, WAS 1.5K; RE-RELEASED;	11/25/56 GHL	WDB 12/14/56	12/14/56
4	RERELEASED	7/10/56 TD	7/10/56	7/10/56

SPECIFICATIONS UNLESS OTHERWISE NOTED

LIMITS OF DIMS.	
ANGULAR	± —
FRACTIONAL	± —
DECIMAL	± —

1. BREAK ALL SHARP CORNERS .005 MAX.
2. SURFACE ROUGHNESS 63 MICROINCH RMS MAX.
3. DIAMETERS TO BE CONCENTRIC WITHIN .005 T.I.R.
4. FILLET RADIUS .010 MAX. 5. THREADS CLASS 2

SCALE: —— DO NOT SCALE DRAWING

MATERIAL: ——

FINISH: ——

DRAWN BY: JA 7-8-57
CHKD BY: BEH 7-8-57
PROJ. ENG: KJ 7-8-57

2608 PRODUCT:

PART NAME: SCHEMATIC

A-2608-501C CHG 6

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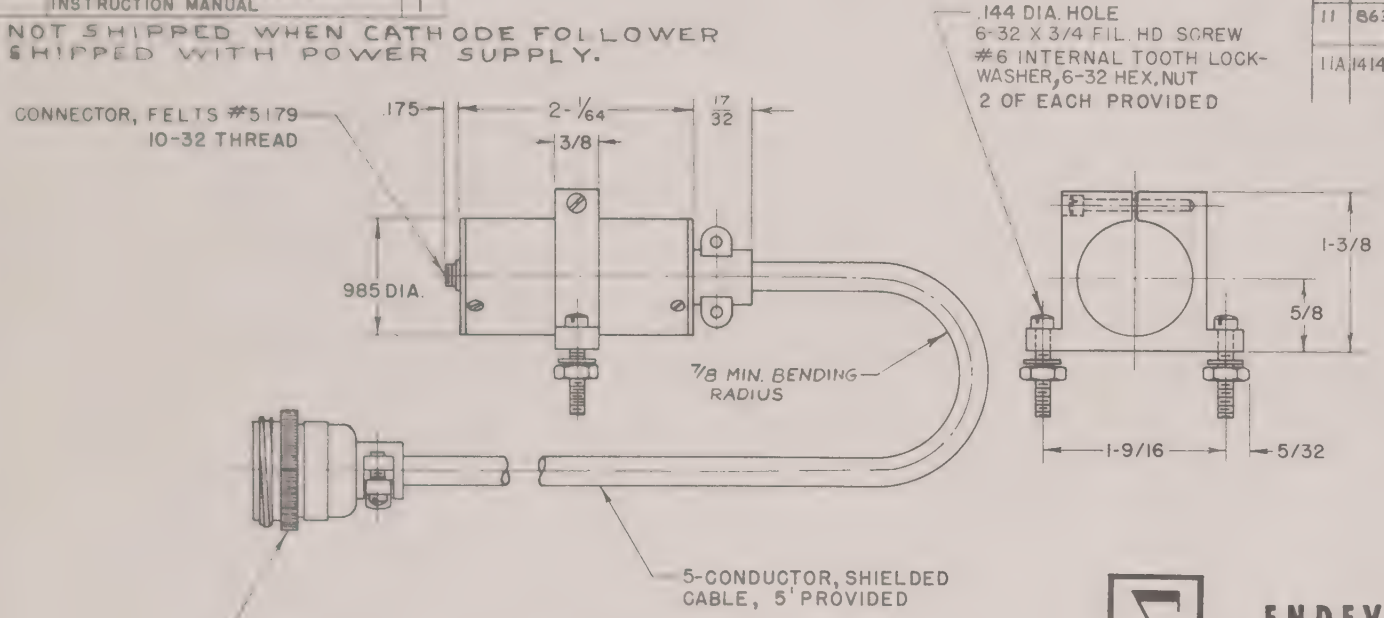
PART NO.	DESCRIPTION	QUAN
2608-1	CATHODE FOLLOWER	1
10337	BRACKET, MOUNTING	1
FHIO	SCR., MACH.-FIL HD. 4-40 X 3/4	1
FH	SCR. MACH. FIL HD 6-32 X 1/4	2
FHWS	LOCK WASHER, #4 INT TOOTH	1
FHW2	LOCK WASHER, #6 INT TOOTH	2
FHN1	NUT, HEX 6-32	2
E/A	RECEPTACLE, CANNON #RW6-3ISL	1 *
	INSTRUCTION MANUAL	1

B-2608-C | 11A

CHG	NO.	CHANGE DESCRIPTION	BY DATE	CHK	APPR
7		REDRAWN & RERELEASED			
8		OVERALL 2 1/64 WAS INCORR. SHOWN 2			
9		ADDED 7/32 ∅ MIN BENDING ALLOWANCE TO CABLE			
10	127	IN S.M. MOUNTING BRACKET WAS PART NO. 2608-1; CATHODE FOLLOWER WAS PART NO. 2608-0;			
11	863	EJ 6 WAS OPTIONAL. ADDED * NOTE.			
11A	1414	5 CONDUCTOR CABLE WAS INCORRECTLY MARKED 6 CONDUCTOR.			

* NOT SHIPPED WHEN CATHODE FOLLOWER IS SHIPPED WITH POWER SUPPLY.



TOTAL WEIGHT: 7 OUNCES

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PASADENA CALIFORNIA

SPECIFICATIONS UNLESS OTHERWISE NOTED			
LIMITS OF DIMS		1. BREAK ALL SHARP CORNERS .005 MAX. 2. SURFACE ROUGHNESS 63 MICROINCH RMS MAX. 3. DIAMETERS TO BE CONCENTRIC WITHIN .005 T.I.R. 4. FILLET RADIUS .010 MAX. 5. THREADS CLASS 2	
ANGULAR	± —		
FRACTIONAL	±1/64		
DECIMAL	±.005	SCALE: FULL	DO NOT SCALE DRAWING
MATERIAL: NOTED			DRAWN BY: JA 6-19-57
FINISH: GRAY CHROMIC ANODIZE			CHKD BY: BH 6-19-57
			PROJ. ENG: KJ 6-24-57
PART NAME			CHG
NEXT ASSEMBLY	CATHODE FOLLOWER	B-2608-C	11 A

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STERLING PRINT BLUEPRINT 1-5004

ENDEVCO SALES OFFICES

If there are any questions concerning this unit, please be sure to contact the nearest Endevco Field Office or the Factory directly.

Eastern Region

Endevco Corporation
912 Bob Wallace Avenue, SW
Huntsville, Alabama
Area Code 205, Telephone 536-1051

Endevco Corporation
306 Busse Highway
Park Ridge, Illinois
TAlcott 5-4600

Endevco Corporation
P.O. Box 145
Greenbelt, Maryland
Telephone 474-3888

Endevco Corporation
440 Lexington Street
Auburndale 66, Massachusetts
WOodward 9-8063

Endevco Corporation
195 Nassau Street
Princeton, New Jersey
Area Code 609, WAlnut 4-3297

Endevco Corporation
611 West Market Street
Akron, Ohio
Telephone 253-3414

Western Offices and Main Plant

Endevco Corporation
29 Whitney Street
Los Altos, California
Telephone 948-1105

Endevco Corporation
801 South Arroyo Parkway
Pasadena, California
SYcamore 5-0271 [redacted]
Cable: ENDEVCO
TWX 213-449-3551

WARRANTY

Endevco Corporation warrants each new instrument to be free from defective material and workmanship for one year from date of sale to the original purchaser. This warranty does not extend to vacuum tubes, transistors and choppers in the units, nor to units which have been misused or used in violation of Endevco recommendations, or to units which have been altered or repaired outside Endevco's factory. Defects covered by this warranty will be remedied at no charge provided the instrument is delivered to the factory with all transportation charges prepaid. If upon examination it is found that the defect is not within the scope of this warranty, a statement of repair charges and a request for authorization to proceed will be submitted.

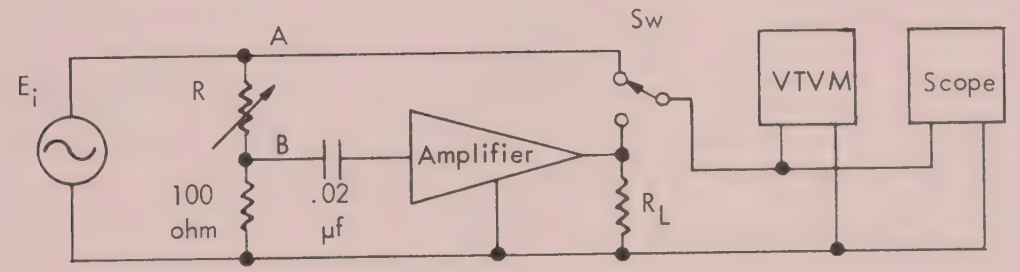
Revised December 1962

dynamic instrumentation Σ

TECH-DATA	NO. 517
AFFECTS	2600 Voltage Amplifiers
CLASSIFICATION	G
REVISION DATE:	5/11/63
ORIGINATOR	B. Epstein

TEST PROCEDURES FOR 2600 VOLTAGE AMPLIFIERS

1.0 AMPLIFIER GAIN



1.1 R should be a continuously variable precision resistor with a calibrated dial. The 100 ohm resistor should have an accuracy of 0.1% or better. The two resistors may be replaced with a precision inductive voltage divider.

1.2 Apply a voltage E_i (5 V RMS at 1000 cps) and adjust the divider setting, so that the output from the amplifier is equal to the voltage at point A. Insure that the voltages are the same by switching Sw, repeatedly.

1.3 The Amplifier Gain, G, is equal numerically to the following when the voltages are equal:

$$G = \frac{R + 100}{100}$$

where R is the value of the variable resistor.

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1.4 Should the amplifier gain be less than 1.000, interchange the leads at A and B, and repeat 1.2. The amplifier gain in this case is given by:

$$G = \frac{100}{R + 100}$$

1.5 Caution: Check signal waveshape to see that noise and distortion are not excessive. Always use a .02 μf or larger coupling to input of amplifier.

1.6 If a precision voltage divider is not available, connect leads at points A and B, together. The Amplifier gain is then the ratio of output to input.

$$G = \frac{\text{Output}}{\text{Input}}$$

This method is relatively inaccurate and may be used when only a rough value of gain need be known.

2.0 FREQUENCY RESPONSE

2.1 The equipment and connections for this test are the same as for Amplifier Gain.

2.2 Apply a voltage E_i (5 V RMS at a reference frequency of 1000 cps) and adjust the divider setting so that the output of the amplifier is equal to the voltage at point A. Insure that the voltages are the same by switching Sw, repeatedly.

2.3 Vary the frequency over the specified range, keeping the input signal, at point A, at constant amplitude. At each frequency adjust the setting of the voltage divider network so that the output of the amplifier is equal to the voltage at point A.

$$\% \text{ Gain Variation} = 100\ \frac{G_f - G_{1000}}{G_{1000}} = 100\ \frac{R_f - R_{1000}}{R_{1000} + 100}$$

where R_{1000} is the value of the variable resistor at 1000 cps

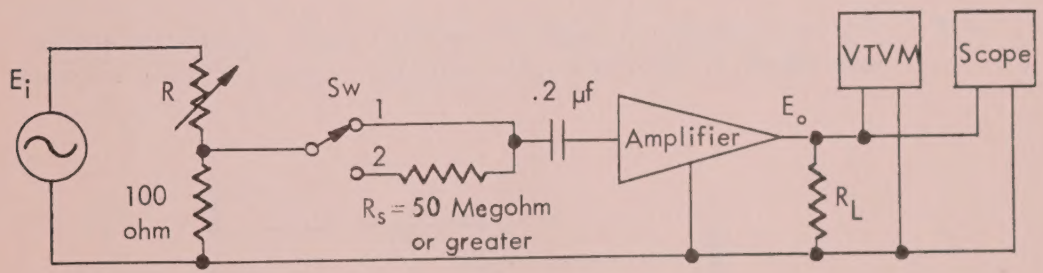
and R_f is the value of the variable resistor at any other frequency.

2.4 Should the amplifier gain be less than 1.000, interchange leads A and B, and repeat 2.2 and 2.3. The % gain variation in this case is:

$$\% \text{ Gain Variation} = 100 \left(\frac{R_{1000} - R_f}{R_f + 100} \right)$$

2.5 Caution: Check the signal waveshape to see that noise and distortion are not excessive.

3.0 INPUT RESISTANCE

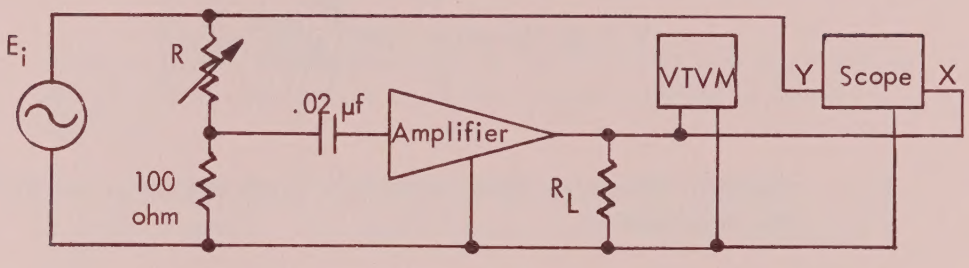


3.1 With switch in position 1, apply a voltage E_i at 5 cycles such that the amplifier output voltage E_{01} is at rated value. With switch in position 2, read amplifier output, E_{02}. The input resistance of the amplifier, R_A, is:

$$R_A = R_S \left(\frac{E_{02}}{E_{01} - E_{02}} \right)$$

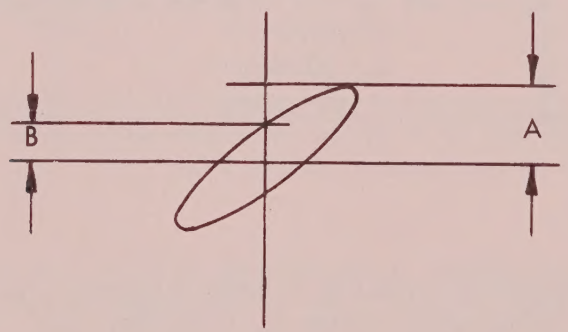
3.2 Caution: Check output signal waveshape for excessive noise pickup.

4.0 PHASE SHIFT



4.1 Adjust the voltage E_i (at a reference frequency, usually 1000 cps) so that the output of the amplifier is at a convenient voltage.

4.2 Vary the frequency through the specified range. Center the ellipse with respect to the oscilloscope graticle. Measure A and B as shown:



4.3 The phase angle, θ, at each frequency is determined from the Lissajous figure using the relationship: $\sin \theta = \pm \frac{B}{A}$. The minus sign is used when the ellipse tilts in the other direction.

4.4 Caution: Check signal waveshape to see that noise and distortion are not excessive.

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